COALBED METHANE DEVELOPMENT – AN ECONOMIC PROFILE

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BUILDING BLOCKS FOR ECONOMIC DEVELOPMENT & ANALYSIS

PREFACE

PURPOSE

Building Blocks have been conceived and developed by the Economic Development Branch of the Ministry of Sustainable Resource Management, under the guidance of Nancy South, Manager Economic Analysis, as an analytical tool that supports British Columbia coastal and land and resource use planning and decision-making and economic development initiatives. The Blocks contain concise business and sector information for a broad range of resource-based business types in BC. At this point, there are more than 30 Blocks either complete or in draft form. Several more Blocks have been identified as high priority by planning tables and other client groups. Additional Building Blocks will be developed over time, and some Blocks may be updated. For the most current Building Blocks, please see the Ministry of Sustainable Resource Management website, at: http://srmwww.gov.bc.ca/rmd/ecdev/

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BENEFITS

Building Blocks are expected to provide the following general benefits:

- Increase efficiency and more informed decision-making by providing readily accessible, credible information to planning and economic development processes;
- Improve the consistency of economic information across planning areas;
- Support economic analysis and decision-making that occurs outside formal coastal and land use planning processes; and
- Provide linkages between economic analysis and other social and environmental analytical tools (through identifying resource requirements to support economic activities and general compatibilities with other sectors and values).

LIMITATIONS

Every effort has been made to ensure that the information contained in Building Blocks is accurate and consistent. Approved, credible data sources are the foundation for Building Blocks. All Blocks were reviewed by sponsoring agencies and other experts. However, users are cautioned that information is used at their own risk, and that the authors and sponsors are not liable for any damages. Any conclusions or interpretations by the authors are not intended to represent government policy. Also, note that Building Blocks do not provide site specific information nor do they consider requirements for sustainability (social, community, environmental).

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RECOMMENDED REFERENCE/CITATION

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1.0 OVERVIEW

1.1 Description of Coalbed Methane

Coalbed methane (CBM), is natural gas formed during the coal maturation process and may in a free or adsorbed state in coal seams in adjacent formations. CBM is dominantly methane but lesser concentrations of carbon dioxide and nitrogen may be found in CBM. However, in most cases, CBM is of sufficient quality for sale directly into natural gas transmission lines with a limited amount of moisture removal.

British Columbia has the second largest projected in-place CBM resource in Canada at an estimated 90 trillion cubic feet ((TCF). Most commercial CBM will be produced from vertical boreholes drilled into and completed in coal seams using methods and equipment similar to those used in the conventional oil and gas industry. Horizontal drilling of multiple wells from a single well pad may be used but to a lesser degree.

1.2 Status of the CBM industry

- Just emerging in Canada after over twenty years of exploration, testing and production trials.
- Presently no commercial production of CBM in British Columbia. Alberta saw its first commercial production in early 2002 and has one project selling CBM.
- Factors ranging from increasing gas prices to the need to find new CBM areas are now creating industry and government interest in the Canadian CBM industry
- CBM in British Columbia faces technical, political and stakeholder challenges. The success and size of the industry will depend on numerous wide-ranging factors, many of which are not yet understood by CBM developers or regulatory bodies due to scarcity of associated public information. Therefore, the projections and estimates made in this Building Block document should be considered to be very general.

1.3 Areas of British Columbia with Potential for CBM Development

- Commercial CBM potential may exist in most areas of BC with defined coal resources
- Because there is no production history, CBM reservoir data is very limited and methods needed for optimum production are not known, identification of CBM potential areas is speculative at present.
- Coal resources in BC occur primarily in physiographic regions defined by geologic structure or in restricted sedimentary basins (See ***Appendix 1*** for areas with CBM resources.)
- Over 85% of BC coal resources occur in the foothills and mountains of NE and SE BC. Much of this area is characterized by rugged terrain, scenic vistas, complex geology and challenging CBM reservoir attributes.
- Other areas of smaller potential such as Vancouver Island and the Hat Creek Basin may have less complex geology and more suitable physiography but may be faced with very stakeholder issues and uncertainty of CBM producibility.

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1.4 Industry Structure and Activity

- All present activity is exploration and pilot well testing. Exploration activities may include seismic, test drilling and reservoir testing.
- Drilling, completion and well treatment using modified oilfield methods and equipment; construction of surface facilities to enable production of CBM for commercial sale
- CBM normally involves removal of ground water from coal seams and adjacent formations to depressurize the reservoir and facilitate gas production. Technical approach is to place wells sufficiently close together to create interactive effect of wells on each other to maximize dewatering and enhance gas production.
- Typical industry approach will be to drill exploration wells to find thick coals with good gas contents, drill one or two 4 to 5 well pilots to verify production and then begin development.
- Development will require multiple wells for projects ranging from 25 to 500 wells, usually drilled in stages of 15 to 50 wells in an increasing radius around a pilot group of wells.
- Compression will be needed due to production of the gas at low reservoir pressures.

2.0 COAST/LAND RESOURCES

CBM Coalbed methane projects typically require fairly contiguous blocks of land to optimize resource production. The need to dewater the coal seams requires closely spaced wells. Typical spacing ranges from one well per 40 acres to one well per 160 acres. (CBM terminology normally refers to this spacing in **acres** due to the great amount of US production experience.)

2.1 Size and Nature of Land Requirement – Single Project Perspective

- These basic necessities of CBM projects create numerous issues for Crown land resources:
- CBM projects normally require relatively contiguous gas rights of at least 4000 to 5000 ha. Most investors will require this number to be in the 10,000 to 20,000 ha range or larger.
- An example: A 10,000 ha block of land (24,700 acres) has sufficient area to support over 300 wells at 80 acre spacing. Not all the area would be used due to land use conflicts, physiography, regulatory restrictions and unsuitable reservoir parameters of certain areas. However, a land block of that size could easily accommodate 200 wells.
- Once a CBM project is producing a cumulative average per well within economic requirements, a core project of 5000 to 10000 acres can double in size. Coal seams are often laterally continuous over extremely large areas. The result can be several 200 to 500 well projects installed over large, relatively contiguous blocks of land.
- See Table 3 at end of document for a 300 well conceptual project.

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2.2 Surface Use Associated with CBM development

- Large blocks of land with closely spaced wells create more surface impact than conventional gas projects. The most intense impact occurs during the construction phase of 1 to 3 years.
- The well sites require roads that can accommodate heavy equipment.
- Each well requires electric power for the dewatering pump as well as gas and water collection lines run to a central point. Water treatment ponds, compressor stations, staging areas, field offices and equipment yards will be included.
- The cumulative effect is a block of land with numerous wells and scattered installations of various sizes of surface facilities. Some typical approximate space requirements for individual CBM surface uses can include (depending on function and project requirements):

Table 1: Typical space requirements for CBM surface uses

Function	Space required – development	Space required - operations
Well sites	.35 hectare (ha)	.15 ha
Water treatment ponds	.02 - 1 ha	no change
Compressor stations (fenced, gravel)	.5 - .75 ha	no change
Field office areas (shops, parking, supply functions)	1 - 1.5 ha	1 ha
Materials storage/equipment yards (away from field office area)	1 - 2 ha	Probably not needed

2.3 Size and Nature of Land Requirement – Provincial prospective.

The degree of ultimate development of these resources is extremely hard to estimate. The lack of commercial CBM production, scarcity of production test data and geologic challenges indicate a wide range in possible development scenarios.

- The total area of coal basins projected to have CBM potential is approximately 2.7 million ha. *(Ref. 3). Appendix 2* provides estimates of estimated gas in place (GIP) and rates of recovery for nine US CBM basins. *(Ref 4)* Average projected recovery for the nine basins is 37%.
- Considering the lack of data available for BC, 37% is probably a high number to apply to projected CBM recovery for the province. Reducing it to 25% is still a very broad generalization but may be realistic. **A further assumption is made that 25% recovery GIP would involve 25% of the land within the limits of the basins with CBM potential.**
- At the assumed recovery rate and percentage of land use for CBM development of 25%, a total of 670,000 ha or 6700 sq. km. would be involved.

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- At 160 acre spacing this provides sufficient land to accommodate the drilling of over 10,000 CBM wells. Drilling wells at 80 acre spacing would double that number to over 20,000 wells.

2.4 Conflicts with Other Uses/Impacts on Resources

- CBM projects involve river valleys, wide scenic ridge tops and areas of low topographic relief that suited to other land uses such as agriculture, rangeland, recreation and construction.
- Potential conflicts: water contamination and use issues, impacts on flora/fauna, problems with dust/traffic/noise/introduction of noxious plants, conflicts with tourism, guiding, grazing and mining, conflicts with First Nations traditional land use.
- Many of these uses can coexist with CBM development but very careful and continuous stakeholder interaction is required. Well site equipment can be reduced to a scale and even appearance that lessens the visual and noise impact. Wildlife, recreational use, grazing, farming and other uses can often coexist with CBM projects in their post-development stages.
- From a Crown resource standpoint, CBM rights must be granted for 20 to 30 years and in some cases, development of coal or other mineral resources may be precluded or postponed. Threshold levels are small for testing programs but once project potential is verified, the threshold requirement will move up to those requirements discussed above.

3.0 INVESTMENT REQUIREMENTS

3.1 Aspects of capital requirements unique to CBM

Coalbed methane development is a large-scale, multifaceted and capital-intensive activity. Certain characteristics unique to CBM wells put them in a capital requirement category that can differ substantially from conventional natural gas wells.

- Wells must be dewatered and peak water production is obtained at beginning of well life.
- As well is dewatered, production increases if the gas contents and reservoir characteristics are good. Peak gas production comes 6 months to 2 years in the life of the well.
- Dewatering process results in the gas being produced at very low pressures. Before the gas can be sold into transmission lines, it must be compressed up to acceptable line pressures.

These characteristics result in capital expenditures early in the life of the project to manage the produced water and provide compression for the gas. This is unique to CBM.

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3.2 Projected Capital Requirements for BC CBM

- Vary considerably over British Columbia and within individual basins
- Capital costs indicated to be highest in the mountains and foothills areas

At this point **there is very little public data available on detailed CBM capital and operating costs in western Canada.** The following table summarizes general estimates for the various **major cost components** likely for wells in various BC CBM potential areas.

Table 2: Projected ranges of capital and operating costs for BC CBM wells

CBM Capital/Operating costs	Foothills/Mountains areas	Other basins/areas
Capital Costs ($1000 per well)		
Land acquisition	10 - 50	10 - 50
Drilling (incl. site prep, tubulars, cement)	300 - 900	150 - 300
Stimulation	80 - 100	70 - 100
Water/gas gathering, electric, wellhead, pump, compression facilities	170 - 375	150 - 350
Water disposal	50 - 100	50 - 100
Total Capital cost	**550 - 1525**	**430 - 900**
Operating costs		
Compression/gas processing	$0.35 – 0.45/mcf (1000 c.ft)	$0.35 - 0.45/mcf
Water disposal	$0.25 -0.75/bbl (barrel)	$0.25 - 0.75/bbl (barrel)
Lease operating expenses	$1200 – 1500 /mo/well	$1200 - 1500/mo/well

Note: These costs assume a sufficiently large project to gain economies of scale (> 25 wells) See Table 3 for the costs associated with a 300 well conceptual project.

3.3 Stages of Capital Requirements

- **Start-up capital requirements** – A CBM project is not normally considered a start-up venture. Most companies who will begin a CBM exploration and development program will have the financial staying power or a funding partner that will provide the up-front investment.
- However, CBM projects are often initiated by an entrepreneur, promoter or small company who will fund an exploration and pilot program either from their own funds or a capital partner. Once good results are obtained from initial testing and pilot production, they will then sell the project or bring in a funding partner for the large-scale development.
- Assuming a midpoint in the prices in the above table, this would require $5 to 10 million in project start-up capital depending on the area and the nature of the CBM resource

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- **Ongoing development capital requirements** – CBM project development requires large capital infusions dependent on the ultimate size of the project, the technical production approach and the nature of the CBM resource and project area. For sake of example, assume a 300-well project in the foothills area. The midpoint capital cost for foothills wells in the table above is about $1000. The approximate cost of this project would be $300 million. Even if this size project can result in fine-tuned methods or increased economies of scale resulting in lower drill costs, say $750,000/well, the total capital cost would still be in the range of $225 million.
- **Future capital requirements** – Once a project reaches the operations stage, most expenses are covered by the proceeds of the project. However, there will still be some major expenses that will be classified as capital costs. Examples would include
  - Completing an additional coal zone in a well,
  - A re-stimulation of a type different from the original,
  - Construction of an additional lateral to a pipeline
  - In-fill drilling to optimize well spacing and production.

These additional capital expenses will vary greatly but could realistically be anticipated to require several million to several tens of millions of dollars per year.

4.0 INFRASTRUCTURE REQUIREMENTS

Coalbed methane projects are large-scale construction projects in the development stage and large-scale production projects during the operations phase. Both phases are highly dependent on several types of major infrastructure. If the infrastructure is not available, it may in some cases have to be built by the CBM producer, thus adding to capital costs.

- **Road systems** – Will accommodate heavy equipment throughout operational life of project.
- **Pipeline access** – Proximity to major transmission lines with adequate capacity and workable tariff structures. Transmission needs for a mid-sized CBM project can be 25 to 50 mmcfd (million cubic ft per day) of capacity.
- **Electric power supply** – CBM projects are large consumers of energy and usually have a high demand for electric power. They are often in areas with under-developed infrastructure and may require construction of major transmission lines to bring in the required supply.
- **Clean water supply** – A critical need for most CBM development project for hydraulic stimulations typically conducted in CBM wells. Each well may have several stimulations using 20 to 40,000 gallons of water in each. In some areas, fresh water lakes or ponds are available and may be accessed where regulations allow
- **Telecommunications infrastructure** – Cellular service or radio repeater towers
- **Emergency services** – Emergency response such as ambulance service, medivac helicopter services. Hospital/clinic facilities.

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5.0 MARKET

- The market for CBM is direct sales to natural gas distribution companies, into the spot gas market or contract sales to industrial consumers.
- Historical North American gas demand and price has continued an overall steadily upward trend and is expected to continue this increase for the long term. The following are some descriptive points relative to overall market outlook:
- North American gas prices have shown a continued overall upward trend since 1991 (*Ref. 5)* even with downward fluctuations during'93 to '95.
- Pricing volatility will continue for short term but overall demand for Canadian gas is continuing to increase while supply is falling behind. (*Ref. 6, 7)*
- Government and industry are concerned about where the gas needed to replace declining western Canadian production will be found. (Ref. 8)
- The demand of the key US market is predicted to grow faster than its production.
- Electric power generation is anticipated to grow rapidly in the northwestern USA and in Canada. One gas-fired generation plant has been built on Vancouver Island and another is under the planning/permit application stages. (One is very near the Comox Basin, which is the most prospective CBM basin on the Island.) Total gas demand from these two 250 MW plants is projected at approximately 90 mmcfd. (*Ref. 9)* This is sufficient demand to take all gas from a several hundred well CBM development.

5.1 British Columbia Outlook

- British Columbia is the second largest producer of natural gas in Canada behind Alberta and the third largest consumer. In 2001, BC consumed 297 bcf of gas. Of the gas not consumed in BC, most is transported on the Westcoast and TransCanada transmission line to the USA.
- The AECO spot price closed at $5.61/mcf this week and *one year AECO gas price futures* were at $5.39/mcf. (*Ref. 10)* This week's prices are the highest in almost a year and a half.
- During the past year, several financial institutions have raised their outlook for gas prices in 2003 to be close to or above the $5/mcf range. (*Ref. 11)*
- The bottom line is that increasing demand, increasing use of gas for electricity generation, declining conventional gas output, a need for new sources of gas and an overall optimistic outlook for price growth indicate good growth opportunities for CBM in BC.

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6.0 LABOUR MARKET/REQUIREMENTS/IMPACTS

6.1 Key Considerations

Should CBM become even a moderately successful industry in British Columbia, the impacts can be very significant to the provincial economy. In considering how to value and plan these impacts, there are two important points to keep in mind:

1. Due to the varied components to a CBM project, types of personnel needed are diverse and the numbers can be great. Skill levels will range from general laborers through trained technicians to professional level scientists and engineers.

2. By far the greatest impacts **for a CBM project** relative to employment and stimulus to the **local and, to some extent regional,** economy will occur during the development stage of the project. Once the project reaches the operations stage, activity level will drop greatly and the numbers of people employed will decrease to a fraction of those present during the construction phase.

The last comment in Point 2. above is important. During the development phase, the number of personnel involved for a 1 to 3 year period may be one to several hundred due to the multi-faceted nature of the project and the need to have multiple major components underway concurrently. However, the onsite project operations group for a CBM program will normally be restricted to 20 to 50 personnel depending on the size of the project, autonomy from corporate headquarters and the operating philosophy of the company.

However, in a type of project development where several development stages for a very large project of say, 500 wells or more, those construction phase personnel could be involved for more than just a few years. In the case of a successful industry that creates numerous projects, these construction phase personnel would normally move from one project to the other or in some cases, make the move to the operations phase of one of the projects.

6.2 Job Types/Skill Levels

The types of personnel needed for the development as well as operations phases of a CBM project will occur in a range too varied and comprehensive to address in text. *Appendix 2* is a tabulation of the types and general numbers of workers needed in both phases and their associated estimated annual wages.

- Most personnel needed will be skilled workers with primary (high school) education and additional technical or on-the-job-training of a few months to a number of years. (Ref. 12).
- Required personnel will be typical of those found in the conventional petroleum industry and should be able to make the transition to CBM without the need for sophisticated training or long lead times. The coal mining industry also provides many of the skill sets that would provide a worker with the basis for becoming a competent CBM employee.
- Projects in areas with conventional activity, such as NE BC, will be the ones with best access to personnel with adequate skill levels. Projects in south BC or on Vancouver Island may experience more difficulty and require significant on-the-job-training.

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6.3 Source of Labour/Other Considerations

- An important point: Most of the work performed during the development stages will be done by contractors and service companies that are now based in areas of concentrated oilfield activity such as Fort Saint John, Calgary, Edmonton and other satellite areas. The net effect can be that much of the impact on wages, income taxes and cash into the economy may not be felt in the project area or even in British Columbia.
- However, the impact of these "remote" workers will of course be significant for local and regional lodging, food service, service station/store and supply businesses.
- In some CBM areas where a number of projects are initiated and development takes place over a prolonged period of time, many of the primary contractors such as well service companies, drilling, workover, pipeline/facilities construction contractors and oilfield supply houses will establish a satellite office or staging area.

6.4 Seasonality/Intensity

- Except in areas of extreme cold and with poor access during inclement weather, most development activity may take place on a year-round basis.
- The operations phases will normally require year-round work unless suspended for very short periods due to extreme cold (even this would be unusual).
- Most CBM or other oilfield work, especially during the development stage, is intense and requires long hours and weekend work for many of the workers. Shift work is common to allow 24 hour activities such as drilling and 7 day per week activities such as well operations. The result is normally a considerable amount of added hours or overtime activity.

6.5 Potential for Employment Generation

CBM projects will vary greatly in size, method of production, number of wells based on spacing and drilling techniques and level of investment available.

However, to provide a very general idea of the amount of employment and value of annual wages, Appendix 3 was developed based on a conceptual project of 300 wells. The type and number of personnel associated with the development stage of the project was estimated based on experience from managing several CBM projects. Review of Appendix 3 shows that:

- The projection assumes that all personnel would be involved for either 1.5 or 2 years.
- The number of people involved during the development stage would be between 135 and 222 personnel during the development stage.
- This equates to a total of 243 to 404 job years for the 2 to 2.5 year period of development.

The same conceptual project can be used to estimate the type and number of people required for the operations phase of a project:

- It is assumed that the company personnel that were present during the development phase of the project remained during operations and are assigned to operate the parts of the project they supervised being installed.

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- The numbers of pumpers and operators would most likely be added in a staggered fashion as needed instead of at the very beginning of the development phase.
- The number of personnel now employed on the project is down to 25 to 37 personnel. However, most of these job types can be assumed to be needed for the project life, which may be 20 to 30 years or more.
- If a 25 year life is assumed, this would equate to 625 to 925 job – years....for one 300 well project.

7.0 CAPACITY

At this point the best that can be done to predict ultimate capacity for the numbers of projects and volumes of production is to base some broad forecasts on assumed percentages of property development or resource recovery.

The Land Resource Requirements section of this document discusses the potential total land requirement for a projected recovery of 25% of the total CBM GIP in British Columbia. Taking this approach a few steps further yields some ideas of the magnitude of development possible:

- A 25% utilization of the provincial lands with CBM potential equates to 6700 sq. km and sufficient area to allow for the drilling of 10,000 wells on 160 acre spacing.
- If that same approach is applied to just the NE BC coal area, the number of wells that could be drilled on 160 acre spacing is over 7000 and over 14000 on 80 acre spacing. Obviously, not all of that 25% portion of the area will be prospective nor can it all be drilled, due to a variety of reasons. However, even if it is cut in half, the area can still accommodate over 3000 to 7000 wells. This is room for 10 to 20 good sized CBM projects.
- Add the potential for doing the same in just the Comox Basin on Vancouver Island and you have the potential for over 300 wells on 80 acre spacing. In SE BC, cutting the 25% land projection allows sufficient land for 350 to 400 wells.
- The critical point here is that there is a very large amount of resource and probably sufficient land to sustain a large CBM industry in BC if the technical, gas price and investment risk can be managed.

8.0 REGULATORY REGIME

The BC government is supportive of CBM development and has taken steps to encourage the exploration and testing and to offer a degree of competitiveness other jurisdictions (*Ref. 12*):

- A revised royalty/tax credit regime with increased concessions applicable to CBM wells.
- Revised legislation concerning test wells that allow more flexible CBM testing.
- Review of oil and gas regulations to simplify permitting and operating requirements.
- More flexible approach to produced water disposal.

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The majority of interaction and regulation will come through two primary groups for oil and gas activity:

Ministry of Energy and Mines – The primary information and interaction for CBM is managed within the Resource Development Division. Three branches of that division are associated with the management of CBM issues:

- *New Ventures Branch* – This group has the lead responsibility for overall information dissemination for CBM resources and issues and liaison with industry and other stakeholders relative to policy, general protocol and activities related to CBM.
- *Titles Branch* – Titles Branch is responsible, from a CBM standpoint, for administering land posting calls, postings, land disposition and tenure as well as policy development relative to Crown land and resource ownership and use.
- *Geological Survey* – Provides the normal research and technical information management, publications and information dissemination to the public.

Oil and Gas Commission – The OGC is the regulatory and enforcement body for oil and gas exploration and development, production and pipelines. This includes CBM, which, at this point, does not have a separate set of regulations.

8.1 CBM Policy/Regulations

Some of the critical issues that may impact CBM development in BC include:

- **Special considerations for CBM**
  - All CBM projects will likely be considered *Experimental Schemes* which give the operator flexibility in testing procedures, reporting, well spacing and operating requirements.
  - Variances will be considered for many requirements or specifications if the operator presents a good case and facts that justify the request
  - Permitting will most likely be allowed on a project basis vs. a single well requirement
  - A set of guidelines summarizing the key regulatory steps and requirements for CBM programs are under development by OGC
  - Restrictions for produced water have been relaxed for certain pilot programs
- **Oil and Gas Tenure**
  - Almost all of the coal and natural gas rights in BC belong to the Crown. The exception is Vancouver Island where substantial freehold rights exist for coal and natural gas.
  - Parcels are posted by industry, reviewed by MEM and then posted for sale.
  - Generally, it is a competitive bid process with tenure granted to highest bidder.
  - Land sales are held monthly and announced in gazette and on web site
- **Blowout Preventor (BOP) requirement** – Standard BOP configuration is required in areas with insufficient sufficient drilling control to demonstrates other less expensive equipment can provide safe working conditions. Once the threat of gas kicks is shown to be low in CBM areas, this could result in cost savings of possibly $50 -100,000.
- **Issues of overlapping coal and natural gas tenures** – CBM and coal mining companies are required to develop cooperative agreements to ensure development of both resources.

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- **CBM ownership issues on Vancouver Island** – The Crown has reiterated policy in recent years stating that CBM rights on Crown land are held by the natural gas owner. This policy has been disputed and argued by the mining industry and others holding coal rights who believe those rights include CBM. It has not been tested in court.
- **Workmen's Compensation Board** – Comments on this BC agency are included here due to specific safety requirements for oil and gas in BC. Discussions among WCB, OGC and industry concerning variances on BOP, distance of flare pit from wellhead and other operational issues may result in significant capital cost savings and reductions in land use impact.

Other regulatory requirements – Other regulatory requirements and agencies may include interaction with First Nations under legal requirements for consultation, interaction with BC Water, Air and Land Protection, Environment Canada and the Department of Fisheries and Oceans.

9.0 GOVERNMENT REVENUES

The major benefit of CBM exploration and production will come from:

- Proceeds from sales of natural gas rights – Bonus bid prices paid for drilling licenses and leases stand to bring major revenues to the provincial government. The October 2002 sale brought in over $21 million for drilling licenses, leases and fees and rental payments for about 51,000 hectares and an average bid price of about $422. Most of the parcels were for conventional activity but at least three parcels totaling over 10,000 ha were purchased by a CBM operator. The average price paid per ha for those parcels was about $390. *(Ref. 13)*
- Production royalties on the sale of CBM -. Production allowances for CBM will preclude collection of much royalty for the first several years of a project. However, once production begins royalties will be paid based on calculations unique to each project. Ministry of Energy and Mines staff have developed an estimated average royalty for general forecasting that considers all of the deductions and credits. The number they use is 10 to 12 percent of gas price sales. *(Ref. 14)*

Other sources of government revenues will include:

- Provincial
  - Employee income taxes – Approximately 1/3 of the total collected for Federal and Provincial income
  - Corporate income taxes of 13.5%
  - Provincial Sales Tax (PST) of 7.5%. This is reduced for the oil and gas industry for purchases of major equipment. In most cases this results in PST being approximately 2% for project expenditures.

Note: A well permit fee of $8400 is charged by the OGC for each well. However this payment is rolled directly into the funding of the OGC and is considered an industry assessment. It would not register as additional revenue to the province.

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- Federal
  - Employee Income Taxes – Approximately 2/3 of the total personal income tax collected
  - Corporate Income Taxes – 26.12% of taxable corporate income
  - GST on purchases – The Goods and Services Tax is 7%
- Local/municipal
  - Revenue may be generated from license, inspection or other government service charges
  - Some municipalities levy accommodation taxes

10.0 INPUT-OUTPUT TABLE

The lack of production history and limited information on gas contents and properties of CBM reservoirs make projections of in-place resources and ultimate recovery of those resources difficult. Furthermore, the ultimate size of the industry is speculative at this point. However, assumptions can be made for a conceptual CBM project to provide a general idea of the input and output relationships associated with one projected project development and production scenario. The following table summarizes some of the key input/out put aspects of one such conceptual CBM project. The assumptions upon which it is based follow the table.

Table 3: Input-output Table for a Conceptual 300 well CBM Program

INPUT	300 Wells Foothills area	300 Wells Other Areas
Total Capital expenditures ($ Million)	300	195
Total area required (hectares)	9720	9720
OUTPUT		
Job Growth/Total salaries		
Jobs for 2 – 2.5 year development period	175	175
Jobs for following 25 year operations period	31	31
Job years for development period	320	320
Job years for operations period	775	775
Total salaries over 27 year project life ($Million)	53.9	53.9
Government Revenue (Provincial) (all in $Millions)		
Royalties at $5/mcf and bonus, rental payments	177.1	177.1
Royalties at $7/mcf and bonus, rental payments	265.7	265.7
Personal income and sales taxes	3.9	3.9
Government Revenue (Federal) (all in $Millions)		
Personal income taxes	7.8	7.8
GST	21	13.6

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10.1 Assumptions

- Table 3 is based on job and salary information in Appendix 3 and in text of document
- For sake of simplicity, the 9720 hectare area is projected to be completely drilled with wells on 80 acre spacing. This is probably not a true case. Most leaseholds will have properties that cannot be drilled for a variety of reasons.
- The numbers of jobs and job-years are taken from the midpoint ranges shown in Appendix 3
- The Total Salaries are calculated using the midpoint range of all the salaries for individual positions and then calculating the average annual salaries for the Development stage ($47,096) positions and for the Operations stage ($50,113) positions. These were multiplied by the mid-point job year values for the two stages.
- Royalties assumed a recent price of $5/mcf at the Sumas sales point. A second scenario of $7/mcf was assumed as an averaged number over project life. For both the $5 and $7 cases, $1/mcf was deducted for transportation from the wellhead and an average royalty rate of 12% was used. (This figure was provided by MEM and takes into consideration cost of services allowances, royalty credits and banked allowances to provide a genera figure for projection)
- The values shown for calculated royalties are not discounted values.
- The value used for Provincial sales tax is 2% (supplied by MEM to represent deductions from the standard sales tax rate for purchases of oilfield capital equipment)
- Provincial and Federal corporate income taxes were not included due to not being able to anticipate a typical taxable corporate income
- Personal income taxes were calculated using a total of 22% for Federal and Provincial and an allocation of 2/3 and 1/3 of the total tax to each respectively.
- The mid-point range of projected capital well costs was used for a conceptual project in the Foothills area and for a project in a restricted basin elsewhere in BC.
- Bonus payments per hectare were assumed to be $400. Rentals were estimated at $3.50/hectare for first 5 years and $7.50/hectare for remainder of project.

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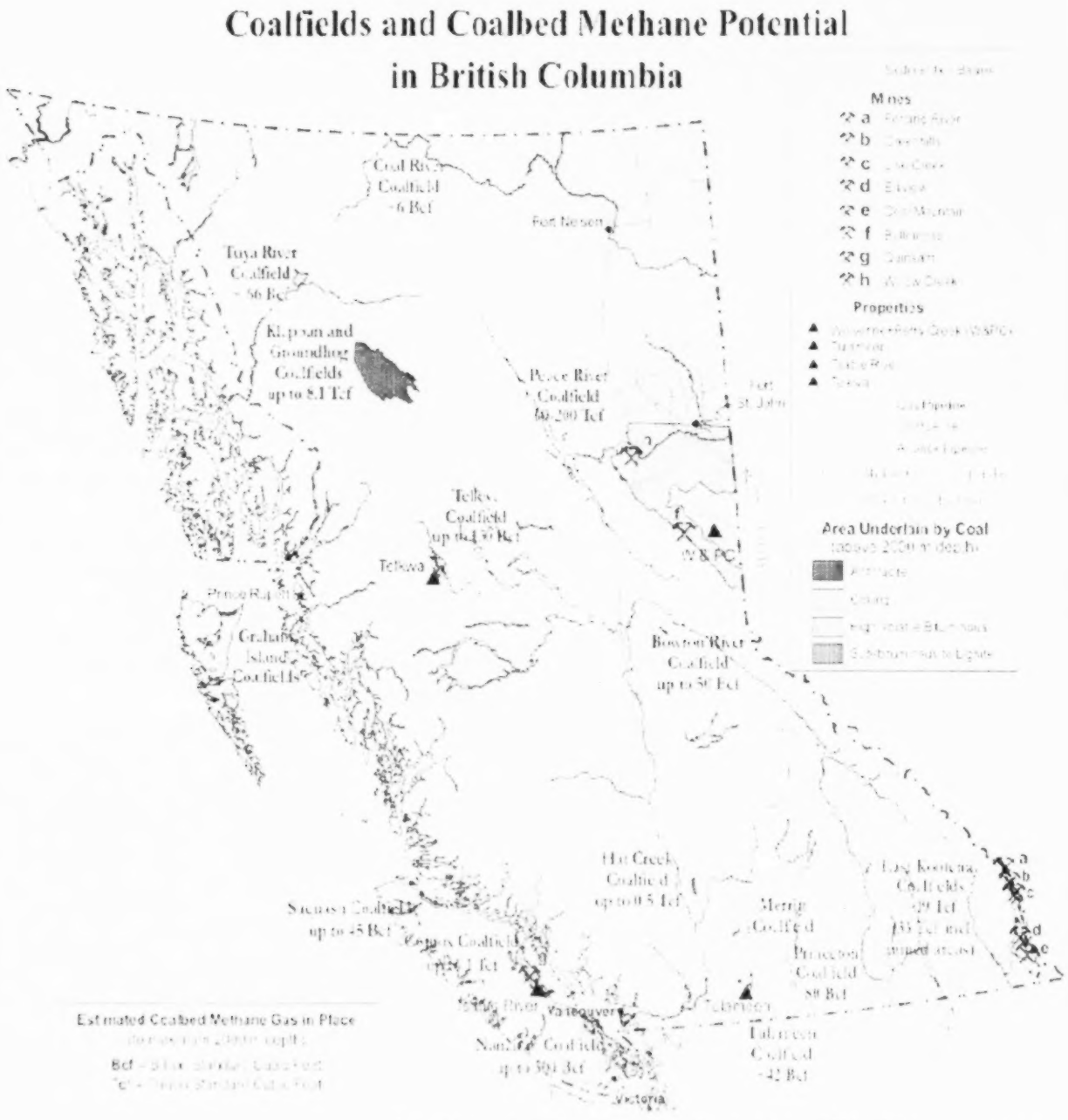
APPENDIX 1 : COALFIELDS AND CBM IN BRITISH COLUMBIA (Ref 2, From Mem)



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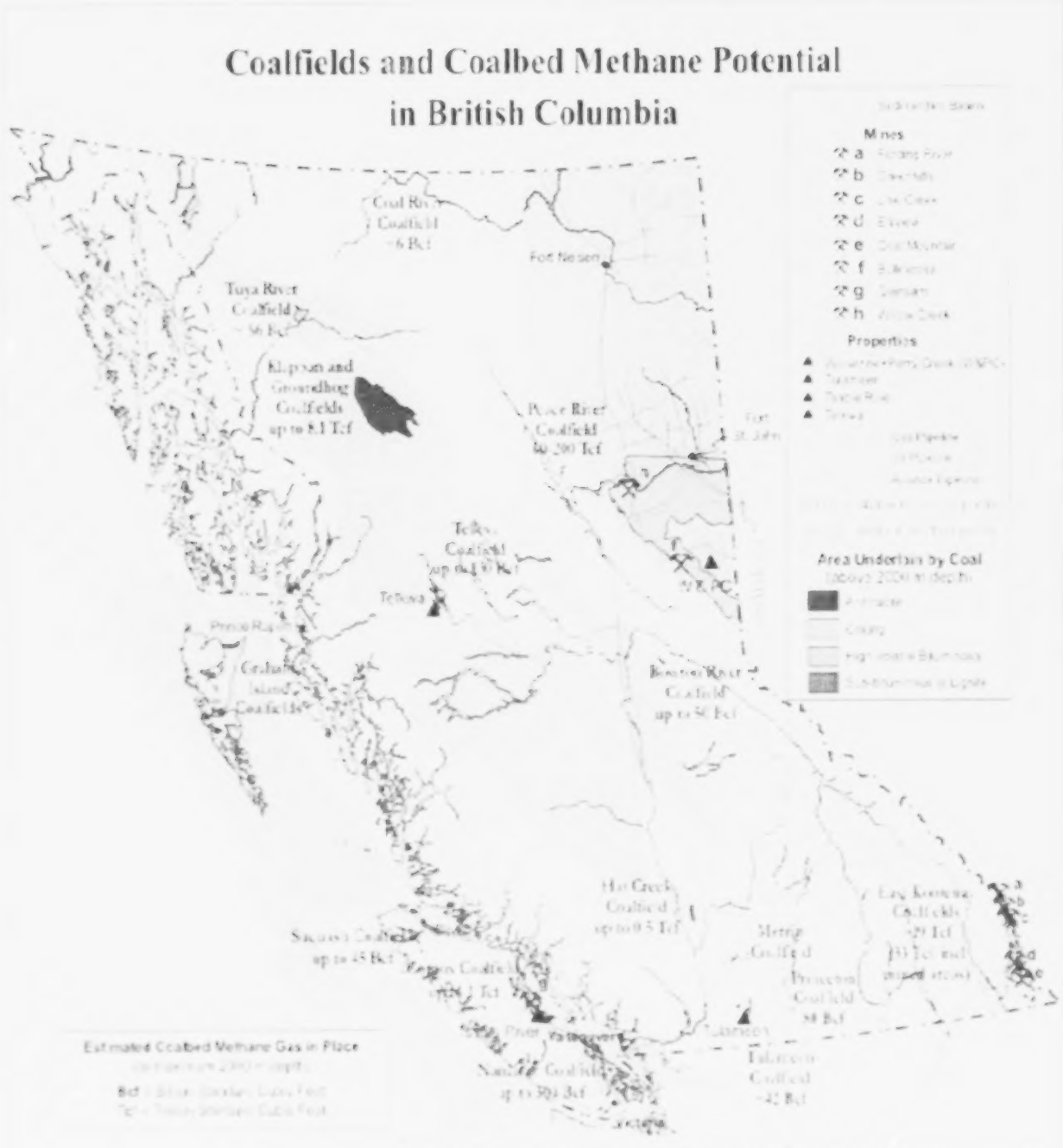
APPENDIX 1 : COALFIELDS AND CBM IN BRITISH COLUMBIA
(Ref 2, From Mem)



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APPENDIX 2 – EXAMPLES OF AMERICAN BASIN RECOVERABLE CBM
(From Alberta EUB/AGS)

Coal Basin	Estimated Resources GIP, TCF	Estimated Recoverable TCF	Recoverable %
San Juan	84	10.2	12
Black Warrior	20	4.4	22
Central Appalacian	5	2.4	48
Powder River	39	24	62
Uinta	10	5.5	55
Arkoma	4	1.8	45
Raton	10	3.7	37
Cherokee	6	2.8	47
Illinois	21	2.1	10
Average recovery from various US CBM basins			37%

source: North American Coalbed Methane Resource Map
GTI E&P Services, GTI-01/0165, 2001

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APPENDIX 3

Employment Projections: Conceptual CBM Project - (see explanation below)

Work Component	Type Worker	Wages (annual)	Est #	Job yrs.
Construction-Roads, well sites, facilities	Superintendents/ Foremen	30,000-50,000	4-6	8-16
(Facilities incl. pipeline, power systems, compressor stations	Equipment operators	25,000-48,000	6-10	12-20
	Welders/fitters/other skilled workers	26,000 – 54,000	15 - 25	30 - 50
	Truck drivers	30,000 – 59,000	5 - 8	10 - 16
	General labor	22,000 – 33,500	30 - 50	60 - 100
Well Drilling/Completion	Drillers	45,000 – 60,000	4 - 6	6 - 9
	Tool pusher/foreman	50,000 – 65,000	1 - 2	1.5 - 3
	Floor hands	35,000 – 53,000	12 - 26	18 - 39
	Specialists (mud engineer, etc)	45,000 – 50,000	2	3
Well Service	Field supervisor	45,000 – 80,000	2 - 3	3 - 4.5
Cement/stimulation	Frac/cement crew	45,000 – 80,000	8 - 15	12 - 22
Well logging	Technician		3 - 5	4.5 - 7.5
Wireline	Tech assistant/labor	22,000 – 33,500	3 - 5	4.5 - 7.5
Workover Rig /Crane	Operator	35,000 – 53,000	3 - 4	6 - 8
Pump setting	Rig hands	30,000 – 50,000	6 - 12	12 - 24
Cleanout				
Wellhead setting				
Trucking/Hauling	Truck drivers	30,000 – 59,000	4 - 6	6 - 9
Equipment moving				
Company Employees				
Foremen, professional,	Project manager	75,000 – 100,000	1 - 2	2 - 4
managers, technicians,	Foremen(drill, ops)	30,000 – 50,000	4 - 5	8 - 10
environmental, pumpers,	Environ tech/water	38,000 – 73,000	1 - 2	2 - 4
labor, clerical, safety	Land/stakeholder	38,000 – 73,000	1	2
	Field/prod. engineer	38,000 – 73,000	2-3	4 - 6
	Pumpers *	24,000 – 48,000	6 - 8	12 - 16
	Operators (compressor/water mgt)	24,000 – 48,000	4 - 6	8 - 12
	Geologist (HQ?)	75,000 – 100,000	1	1
	Communication tech	31,000 – 57,000	1 - 2	1.5 - 3
	Clerks	20,000 – 32,000	2	4
	Labor/roustabout	22,000 – 33,500	3 - 5	6 - 10
Totals for personnel/ job years		**$933,000 – 1,516,000**	**135-222**	**243-404**

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Explanation

- Table represents one conceptual 300 well project
- Assumes staged development of overlapping (timing) 50 well groups for 2 to 2.5 year period
- Assumes workers do not merge into other functions once their job complete
- No wages provided for foremen/supervisory workers due to the wide variation in experience levels and compensation. Also is assumed they will move on to other jobs with company if work is short term
- No wages for professional level engineers/scientists due to possible sporadic association with project and support provided from an HQ location
- Wages based on website information of *Petroleum Services Association of Canada*. Worker categories were matched to best PSAC category fit and wages rounded. Where not available, I estimated this based on my experience
- Construction contractors: 2 to 3 separate companies
- To calculate man years, a total time on project was assumed to be either 1.5 or 2 years (at author's discretion based own project management experience)

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